



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Alaska Fisheries Science Center
Resource Assessment and Conservation
Engineering Division
7600 Sand Point Way Northeast
BIN C15700, Building 4
Seattle, Washington 98115-0070

September 16, 1991

CRUISE RESULTS
NOAA SHIP MILLER FREEMAN
Cruise No. 91-02
Echo Integrator/Midwater Trawl Survey
of Spawning Pollock in Shelikof Strait

CRUISE PERIOD, AREA, AND SCHEDULE

National Marine Fisheries Service (NMFS), Alaska Fisheries Science Center (AFSC) personnel conducted an echo integrator/midwater trawl (EIMWT) survey of pelagic walleye pollock (Theragra chalcogramma) resources in Shelikof Strait and near Sanak Island aboard NOAA R/V Miller Freeman during March 1991. The vessel's itinerary was as follows:

March 15	Depart Dutch Harbor, Alaska. Transit to Sanak.
March 16	Survey Sanak area.
March 17	Transit to Shelikof Strait.
March 18-24	Shelikof Strait survey 1.
March 25-27	Shelikof Strait survey 2.
March 27	Standard sphere calibration in Malina Bay.
March 28	Arrive Kodiak, Alaska.

OBJECTIVES

EIMWT surveys have been conducted in the Gulf of Alaska annually since 1980 (except 1982). Each of these surveys was designed to estimate the biomass of spawning pollock in Shelikof Strait. The 1991 cruise was the latest in this series of surveys. The principal objectives of the cruise were to:

1. Collect echo integration and midwater trawl data necessary to determine the distribution, biomass, and biological composition of spawning pollock in Shelikof Strait.



2. Conduct further comparisons between a new acoustic assessment system and the system used in all previous surveys.
3. Calibrate both acoustic systems using standard sphere techniques.
4. Collect biological samples for pollock reproduction and stock structure studies and oil contamination analysis.
5. Take photographs of whole and dissected pollock for morphometric research and maturity stage documentation.
6. Spawn pollock and culture the fertilized eggs for laboratory experiments on larval growth rate and metabolism.

VESSEL, ACOUSTIC EQUIPMENT, AND TRAWL GEAR

The survey was conducted on board the NOAA ship Miller Freeman, a 66 m (216 ft) stern trawler, equipped for fisheries and oceanographic research. Two 38 kHz echo sounding systems were used: one employing a Simrad¹ split beam transducer attached to the vessel's centerboard and the other a towed body system with a Biosonics split beam transducer. The Simrad transducer was mounted on the distal end of the centerboard at a depth of 10 m below the surface with the centerboard fully extended. The Biosonics transducer was housed in a dead-weight fin and towed at a depth of 10-15 m below the surface approximately 60 m behind the vessel. The Simrad transducer was connected to a Simrad EK500 echo sounding system. The Biosonics transducer was connected to a custom developed transmitter and receiver interfaced with a Hewlett Packard 1000 computer. System electronics were housed in a portable laboratory mounted on the weather deck of the vessel. Data from the Simrad EK500 echo sounder/receiver were processed using Simrad BI500 echo integration and target strength data analysis software on a SUN workstation computer. Acoustic data from the Biosonics system were processed using the Hewlett Packard 1000 computer.

Midwater echo sign was sampled using a modified Northern Gold 1200 midwater rope trawl (NET Systems, Inc.). The trawl was constructed with ropes in the forward section and stretch mesh sizes ranging from 163 cm (64 inches) immediately behind the rope section to 8.9 cm (3.5 inches) in the cod end. It was fitted with a 3.2 cm (1.25 inch) mesh cod end liner. Headrope and footrope lengths were 94.5 m (310 ft) and 50 m (164 ft), respectively, and the breastlines measured 79.4 m (260.5 ft). The net was fished in a bridleless configuration with 1.8 m X 2.7 m (6 ft X 9 ft) steel V-doors and 227 kg (500 lb) tom weights on each side. Trawl mouth opening and depth were monitored with a Furuno wireless netsounder system attached to the headrope of the trawl.

¹ Reference to trade names or commercial firms does not constitute U.S. government endorsement.

Fish on and near bottom were sampled with an 83/112 bottom trawl without roller gear. The bottom trawl had mesh sizes ranging from 10.2 cm (4 inches) forward to 8.9 cm (3.5 inches) in the cod end, fitted with a 3.2 cm (1.25 inch) cod end liner. Headrope and footrope lengths were 25.6 and 34.1 m (83.9 ft and 111.9 ft), respectively. Breastlines measured 3.4 and 3.2 m (11.3 and 10.5 ft).

Water temperature/salinity profile data were collected at trawl and calibration sites using a Seabird CTD (conductivity/temperature/depth) system. Additional temperature/depth information was obtained by making occasional expendable bathythermograph (XBT) casts. The surface temperature was measured with a bucket thermometer at each trawl location.

SURVEY METHODS

En route to Shelikof Strait, a brief survey was conducted offshore of Sanak Island to investigate previous reports of spawning pollock occurrence and to collect biological samples for the oil contamination study (Figure 1). The survey consisted of three parallel transects, approximately 10 nautical miles (nmi) apart, that traversed the area between the 91 m (50 fm) and 910 m (500 fm) isobaths.

The first survey of Shelikof Strait took place between March 18 and 24 and consisted of twenty-five 7.5-nmi spaced parallel transects traversing the strait between the 91 m (50 fm) isobaths (Figure 2A). The upper portion of Shelikof Strait was surveyed a second time between March 25 and 27; the design was similar to that employed during the first survey, but only 13 transect lines were completed and offset 3.75 nmi to the south (Figure 2B).

Survey operations were conducted both day and night. Vessel speed varied between 6 and 12 knots, depending upon weather conditions. Echo integrator density estimates were computed at 1-minute intervals for each of up to 400 contiguous 1-m depth strata between the transducer and the bottom. Midwater and demersal trawl hauls were made at selected locations to identify echo sign and provide biological samples (Figures 1 and 3). The duration of each trawl haul depended on the time considered necessary (based on observation of the netsounder display) to capture enough fish for biological sampling purposes. The average trawling speed was about 3 knots. The vertical net opening for the midwater trawls ranged between 18 and 25 m (59-82 ft). A single measurement for a bottom trawl vertical net opening was recorded at 3.5 m (11.5 ft). For each trawl haul, the total catch weight and the number of each species caught was determined. Walleye pollock were further sampled to determine sex, length, weight, age, maturity, and ovary weight. Other pollock samples were preserved for reproduction and stock structure studies. To determine the exposure of pollock to hydrocarbon contamination, bile, ovary, liver, and stomach samples were collected.

Standard sphere calibrations of both acoustic data collection systems were conducted March 27. This was accomplished by measuring the response of each system to a standard copper sphere (with known acoustic properties) under each system's transducer while the vessel was anchored fore and aft in 60-100 m of water. A system calibration was also completed earlier on March 4 during Miller Freeman cruise 91-1. The measurements from both calibrations will be used to interpret the data collected during Miller Freeman cruise 91-2.

RESULTS

A total of 17 midwater and 2 bottom trawl hauls were conducted during the survey (Figures 1 and 3). Catch results are summarized in Table 2. Total catch numbers and weight for each species taken are shown in Tables 3 and 4. A tally of the biological samples and photographs collected for pollock are presented in Table 5. A total of 16 CTD casts (Table 6) and 7 XBT casts (Table 7) were made. Pollock eggs were collected and fertilized from samples obtained during hauls 11 and 19.

During the survey off Sanak Island, approximately 27 nmi of transect line was surveyed and one midwater trawl was conducted (Figure 1). A small area of moderately dense echo sign was detected; midwater trawl sampling through this sign produced a catch of large adult pollock (Figure 4A). The maturity composition obtained from 70 female pollock in the sample was 3% developing and 97% mature. For the 15 male pollock sampled, 7% were developing, 27% mature, and 67% were in spawning condition.

During the first survey of Shelikof Strait, approximately 669 nmi of acoustic transects were surveyed. In the southernmost portion of the survey area, south of Sitkinak Strait, very little acoustic sign was observed (Figure 2A). Pollock began to appear in relatively low densities north of Sitkinak Strait and then in higher densities to the north of Middle Cape. In this central area of Shelikof Strait, much of the echo sign was near-bottom (within about 10-15 m of bottom); midwater trawl hauls through this sign generally produced pollock ranging from 18-63 cm with the predominant mode around 28 cm (Figure 4B). In the central and northeastern part of the strait, midwater schools of pollock were often encountered; trawling through these schools obtained pollock with a length range of around 20-45 cm, and again, the predominant mode was about 28 cm (Figure 4C). The northwest region of the strait has historically contained the highest densities of pollock during surveys carried out in March. For this survey, the densest pollock aggregations were also in this portion of the strait, particularly off Cape Kuliak. Both near-bottom and dense midwater echo sign were observed. Trawling through the midwater layer generally produced pollock ranging between 11-58 cm with most fish in the 42-52 cm range (Figure 4D). A bottom trawl haul produced fish in the

14-65 cm length range, with most of the fish occurring between 44-56 cm (Figure 4E).

A second survey, mostly in the northern part of the strait, revealed a pattern of distribution and abundance similar to that observed during the first survey (Figures 2A and B). Approximately 304 nmi of acoustic transects were covered.

Shelikof Strait pollock were sampled for maturity using both midwater and bottom trawls. No pollock smaller than 34 cm fork length were found to be sexually mature. The maturity composition of females 34 cm or longer sampled with the midwater net (347 fish) was 43% developing, 52% mature, 3% in spawning condition, and 1% spent. Males 34 cm or longer (477 fish) were 17% developing, 12% mature, and 71% spawning. Maturity compositions for pollock of the same length range taken by bottom trawl appeared to be somewhat different, but this may have been due to smaller sample sizes. Female maturities (87 fish) were found to be 13% developing, 80% mature, 2% spawning, and 5% spent. Male maturities (18 fish) were 28% mature, 61% spawning, and 11% spent.

SCIENTIFIC PERSONNEL

William Karp	Chief Scientist	AFSC
Daniel Twohig	Electronics Technician	AFSC
Ed Nunnallee	Fishery Biologist	AFSC
Denise Adams	Fishery Biologist	AFSC
John Garrison	Electronics Technician	AFSC
Nazila Merati	Fishery Biologist	AFSC
Carla Stehr	Fishery Biologist	NWFSC
Yoshimi Takao	Fishery Engineer	JFA
Young Hee Hur	Fishery Biologist	NFRDA

AFSC - Alaska Fisheries Science Center, Seattle, Washington
 NWFSC - Northwest Fisheries Science Center, Seattle, Washington
 JFA - Fisheries Agency of Japan, National Research Institute of Fisheries Engineering, Tokyo, Japan
 NFRDA - National Fisheries Research and Development Agency, Pusan, Korea

 For further information contact Dr. Gary Stauffer, Director, Resource Assessment and Conservation Engineering Division, Alaska Fisheries Science Center, National Marine Fisheries Service, 7600 Sand Point Way NE., Building 4, BIN C15700, Seattle, WA 98115-0070. Telephone (206) 526-4170.

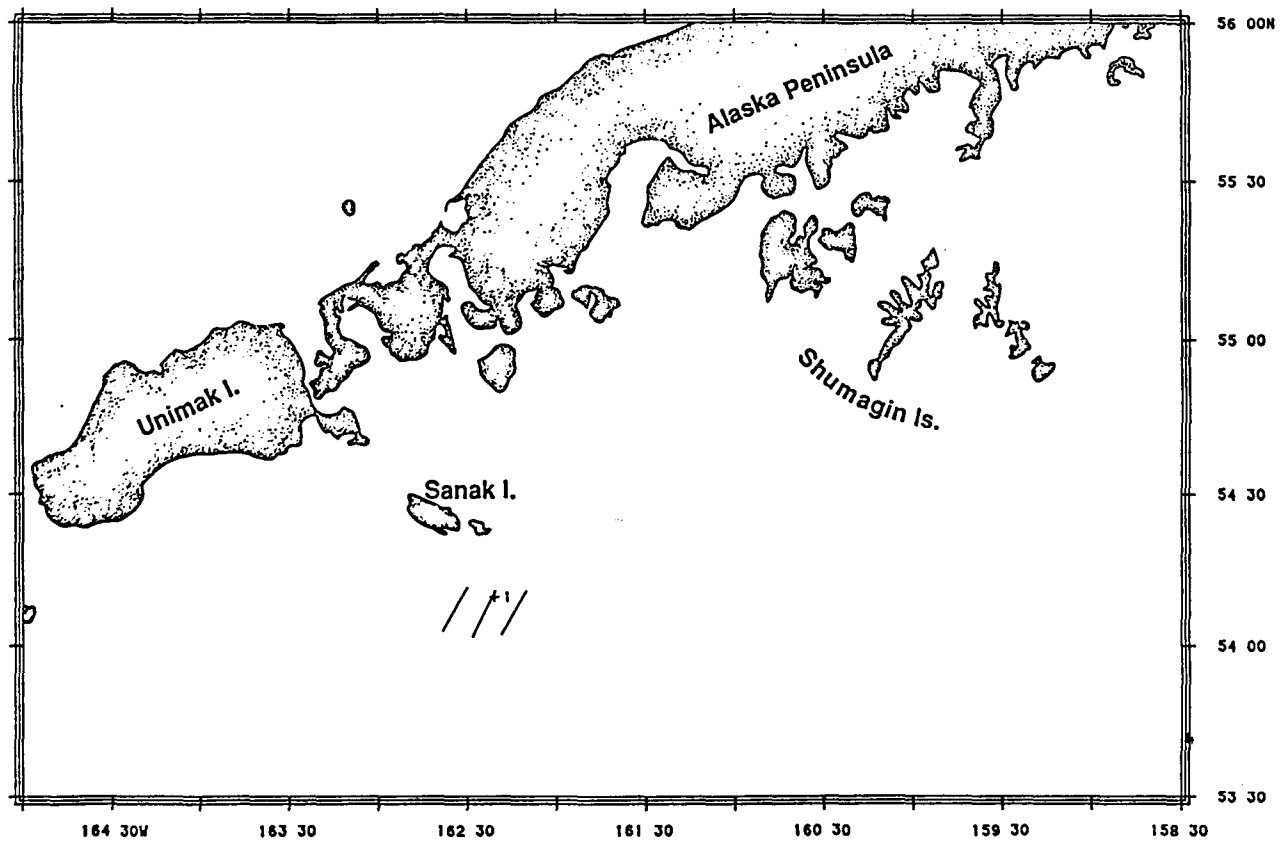


Figure 1. Acoustic transects surveyed off Sanak Island. Trawl station indicated by +.

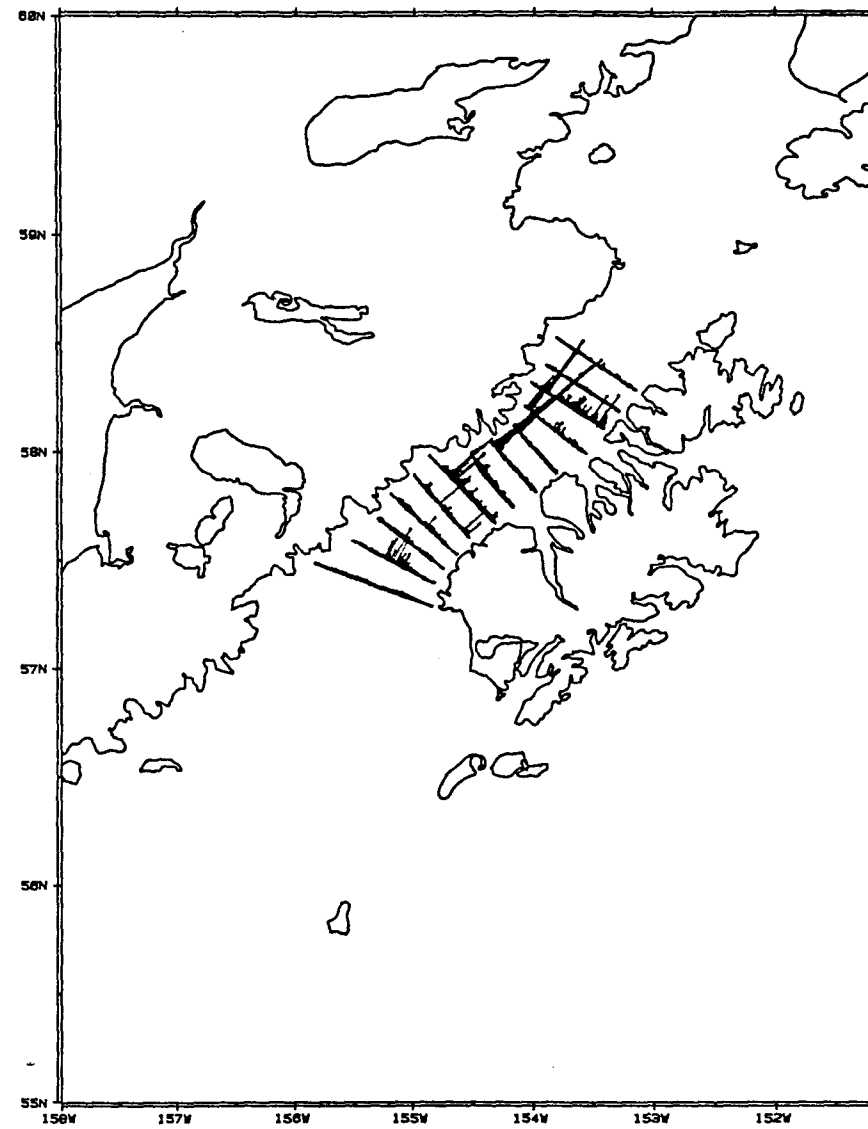
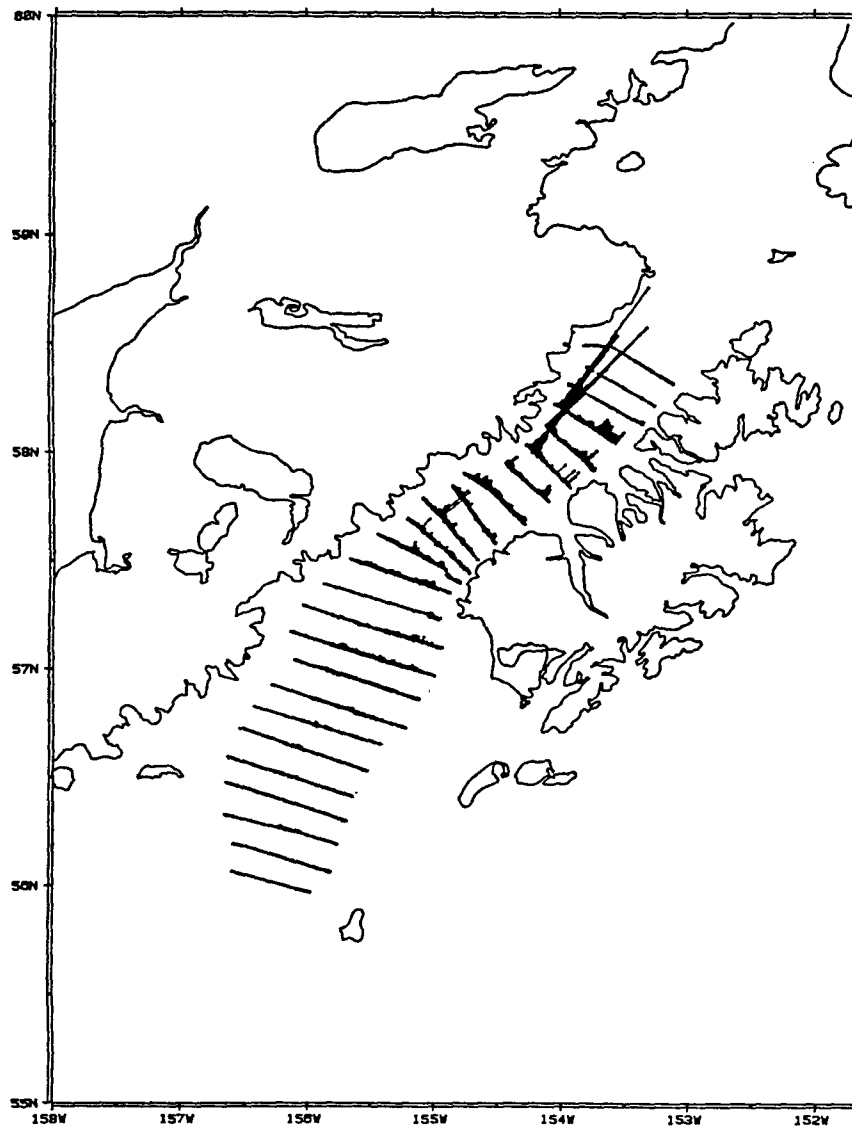


Figure 2. Acoustic transects surveyed in Shelikof Strait during first (A) and second (B) passes. Deflections off transect lines indicate relative fish density.

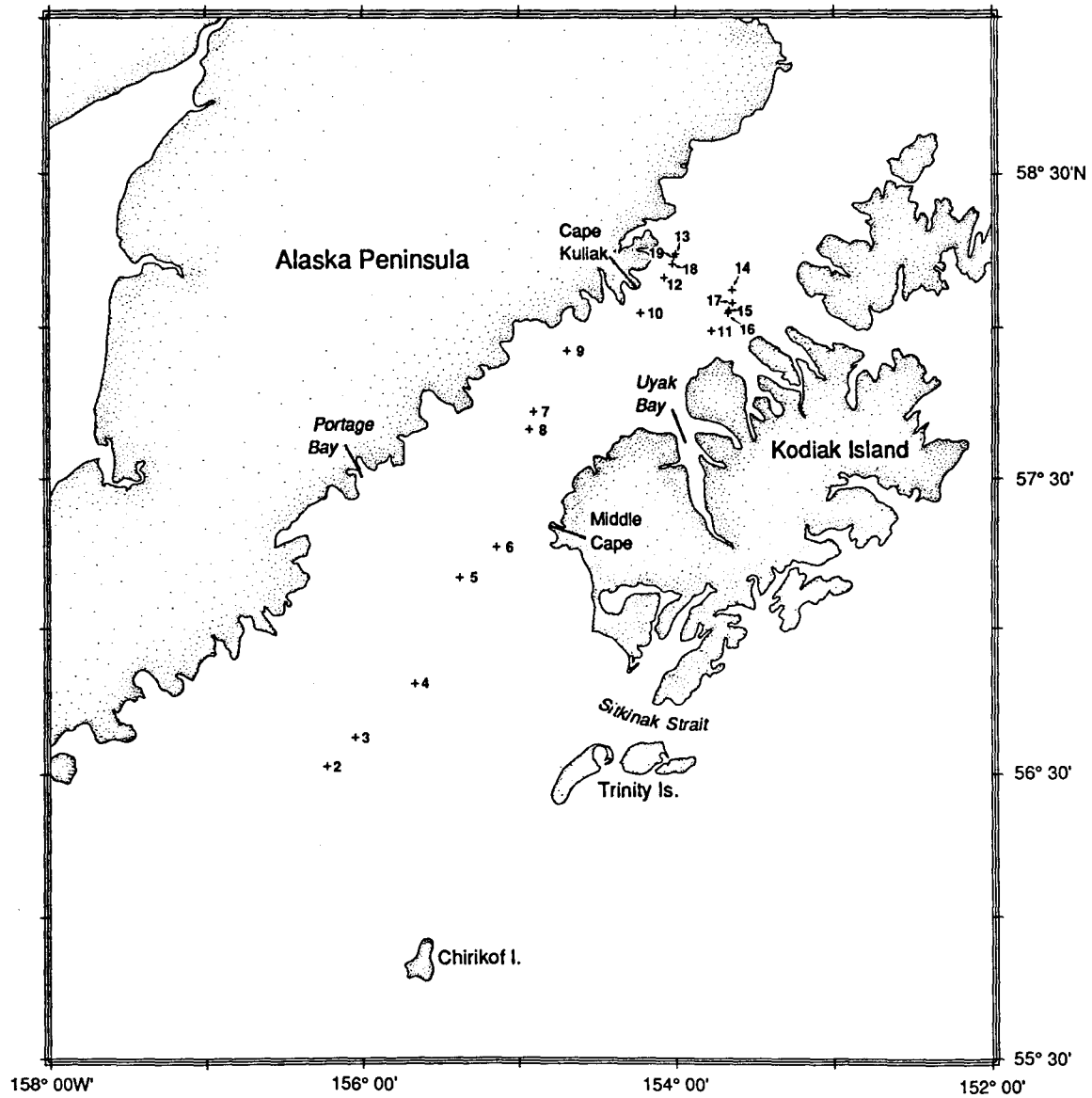


Figure 3. Shelikof Strait indicating the location of midwater and bottom (17 & 18) trawl stations.

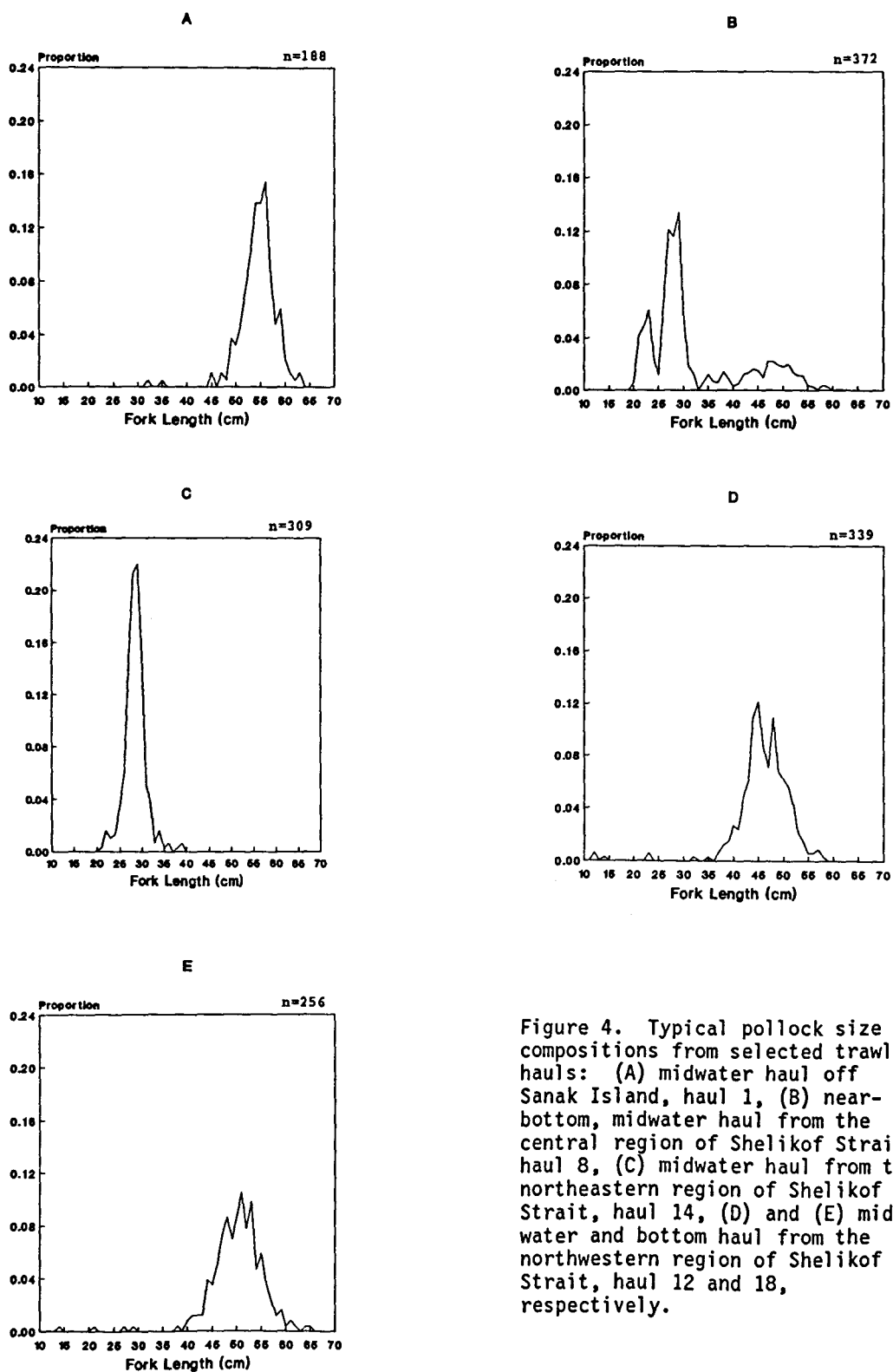


Figure 4. Typical pollock size compositions from selected trawl hauls: (A) midwater haul off Sanak Island, haul 1, (B) near-bottom, midwater haul from the central region of Shelikof Strait, haul 8, (C) midwater haul from the northeastern region of Shelikof Strait, haul 14, (D) and (E) midwater and bottom haul from the northwestern region of Shelikof Strait, haul 12 and 18, respectively.

Table 1. Standard sphere calibration summary for the Miller Freeman cruise 91-1 and 91-2.

Date (1991)	Location	<u>Transducer depth (m)</u>	
		System 1 (Towed body)	System 2 (Centerboard mounted)
Jan. 31- Feb. 1	Port Susan, Puget Sound, WA	no calibration	10
Feb. 9-10	Malina Bay, Kodiak Island, AK	10, 15, 20	10
Mar. 4	Cannery Bay, Unalaska Island, AK	5, 10, 12.5, 15, 20	10
Mar. 27	Malina Bay, Kodiak Island, AK	15	10

Table 2. Midwater trawl station and catch data, from the winter 1991 Gulf of Alaska pollock survey, Miller Freeman cruise 91-2.

HAUL NO.	AREA*	DATE (1991)	TIME (AST)	START POSITION LAT. (N) LONG. (W)		TRAWL TEMP (C)	SURF TEMP (C)	TRAWL DEPTH (FM)	BOTM DEPTH (FM)	CATCH (LBS/NOS.)		
										WALLEYE POLLOCK	EULACHON	OTHER
1	SA	16 MAR	0605-0626	54 09.6	162 20.7	2.7	4.5	167	285	1172/396	0	203/45
2	SH	20 MAR	0344-0404	56 31.6	156 13.9	2.1	4.9	130	147	1039/2469	50/806	25/55
3	SH	20 MAR	0940-0951	56 37.7	156 03.1	2.7	5.1	145	160	1496/4356	42/1562	9/7
4	SH	20 MAR	2031-2101	56 48.8	155 40.1	2.8	4.7	115	152	924/2402	17/674	21/5
5	SH	21 MAR	1050-1106	57 10.4	155 22.8	2.8	-	133	137	2800/7814	1831/13866	369/103
6	SH	21 MAR	2118-2143	57 16.4	155 08.8	2.8	3.9	83	128	960/2959	0	9/4
7	SH	22 MAR	0956-1013	57 43.3	154 54.3	2.9	3.9	80	136	4420/13714	0	0
8	SH	22 MAR	1151-1200	57 39.9	154 56.0	2.9	-	124	126	1391/1897	1404/9513	44/22
9	SH	23 MAR	0108-0123	57 55.4	154 41.6	2.9	3.2	114	136	1474/1713	59/528	14/3
10	SH	23 MAR	1103-1109	58 03.0	154 13.5	2.9	3.7	137	148	1831/1086	0	4/3
11	SH	23 MAR	2208-2213	57 59.5	153 46.3	2.8	4.5	103	126	2640/7511	0	10/4
12	SH	24 MAR	1121-1124	58 09.9	154 04.4	2.4	4.3	136	161	1047/606	6/36	17/5
13	SH	24 MAR	1355-1358	58 14.5	153 59.9	2.3	4.3	128	150	2545/1392	14/151	17/5
14	SH	24 MAR	1805-1806	58 07.4	153 38.4	2.9	2.6	50	109	5870/17479	0	0
15	SH	25 MAR	1028-1029	58 03.6	153 39.7	2.7	4.0	77	115	1020/1900	0	0
16	SH	25 MAR	1221-1243	58 03.1	153 40.1	3.0	-	115	116	685/1173	154/2002	77/74
**17	SH	25 MAR	1424-1441	58 04.8	153 38.3	2.9	-	110	110	141/83	46/329	2731/3239
**18	SH	25 MAR	1845-1855	58 12.5	154 01.3	3.3	-	151	151	2694/1102	2/28	1885/440
19	SH	25 MAR	2110-2113	58 14.0	154 00.7	3.3	4.2	118	150	1586/1228	10/96	5/3

* SA = Sanak, SH = Shelikof Strait

** Bottom trawls

Table 3. Summary of catch by species for 17 midwater trawls, from the winter 1991 Gulf of Alaska pollock survey, Miller Freeman cruise 91-2.

<u>SPECIES</u>	<u>NUMBERS</u>	<u>PERCENT</u>	<u>WEIGHT (lb)</u>	<u>PERCENT</u>
Walleye Pollock (<u>Theragra chalcogramma</u>)	70095	70.3	32900	88.2
Eulachon (<u>Thaleichthys pacificus</u>)	29234	29.3	3588	9.6
Pacific Cod (<u>Gadus macrocephalus</u>)	8	<.1	67	0.2
Smooth Lumpsucker (<u>Aptocyclus ventricosus</u>)	31	<.1	91	0.2
Squid Unidentified	227	0.2	62	0.2
Lanternfish Unidentified (Myctophidae)	20	<.1	1	<.1
Shark Unidentified	1	<.1	330	0.9
Jellyfish Unidentified (Scyphozoa)	3	<.1	3	<.1
Salps Unidentified (Thaliacea)	1	<.1	1	<.1
Arrowtooth Flounder (<u>Atheresthes stomias</u>)	12	<.1	32	0.1
Sockeye Salmon (<u>Oncorhynchus nerka</u>)	2	<.1	2	<.1
Chinook Salmon (<u>Oncorhynchus tshawytscha</u>)	8	<.1	33	0.1
Giant Grenadier (<u>Albatrossia pectoralis</u>)	2	<.1	18	<.1
Pacific Ocean Perch (<u>Sebastes alutus</u>)	23	<.1	184	0.5
Totals	99667	100.0	37312	100.0

Table 4. Summary of catch by species for 2 bottom trawls, from the winter 1991 Gulf of Alaska pollock survey, Miller Freeman cruise 91-2.

<u>SPECIES</u>	<u>NUMBERS</u>	<u>PERCENT</u>	<u>WEIGHT (lb)</u>	<u>PERCENT</u>
Walleye Pollock (<u>Theragra chalcogramma</u>)	1185	22.7	2834	37.8
Eulachon (<u>Thaleichthys pacificus</u>)	357	6.8	48	0.6
Pacific Cod (<u>Gadus macrocephalus</u>)	1	<.1	6	0.1
Smooth Lumpsucker (<u>Aptocyclus ventricosus</u>)	1	<.1	2	<.1
Squid Unidentified	5	0.1	13	0.2
Sea Urchin Unidentified	5	0.1	1	<.1
Flathead Sole (<u>Hippoglossoides elassodon</u>)	281	5.4	256	3.4
Arrowtooth Flounder (<u>Atheresthes stomias</u>)	1605	30.7	3301	44.0
Shrimp Unidentified	1458	27.9	18	0.2
Rougheye Rockfish (<u>Sebastes aleutianus</u>)	6	0.1	16	0.2
Pacific Halibut (<u>Hippoglossus stenolepis</u>)	10	0.2	227	3.0
Bairdi Tanner Crab (<u>Chionoecetes bairdi</u>)	78	1.5	60	0.8
Snail Unidentified	132	2.5	24	0.3
Dover Sole (<u>Microstomus pacificus</u>)	22	0.4	36	0.5
Rex Sole (<u>Glyptocephalus zachirus</u>)	16	0.3	14	0.2
Spinyhead Sculpin (<u>Dasycottus setiger</u>)	14	0.3	2	<.1
Giant Wrymouth (<u>Delolepis gigantea</u>)	2	<.1	27	0.4
Alaska Plaice (<u>Pleuronectes quadrituberculatus</u>)	1	<.1	1	<.1
Big Skate (<u>Raja binoculata</u>)	2	<.1	98	1.3
Longnose Skate (<u>Raja rhina</u>)	17	0.3	417	5.6
Starry Skate (<u>Raja stellulata</u>)	5	0.1	98	1.3
Side-stripe shrimp (<u>Pandalopsis dispar</u>)	18	0.3	1	<.1
Totals	5221	100.0	7500	100.0

Table 5. Summary of pollock biological samples and measurements, for the winter 1991 Gulf of Alaska pollock survey, Miller Freeman cruise 91-2.

HAUL NO.	LENGTH	WEIGHT & MATURITY	OTOLITH	GONAD WEIGHT	STOCK IDENTIFICATION			FISH SAMPLED FOR OIL CONTAMINATION STUDY ₂	REPRODUCTION STUDIES		
					MORPHOLOGY PHOTOGRAPH	TISSUE SAMPLE ₁	OTOLITH		OVARY & OTOLITH	GONAD PHOTOGRAPH	BLOOD SAMPLE ₃
1	188	75	75	73	10	102	10	15	-	-	8
2	222	74	74	-	-	50	50	15	-	-	-
3	495	87	87	45	-	-	-	-	23	-	-
4	481	57	29	19	-	142	13	15	-	-	-
5	453	131	129	-	-	108	108	15	26	-	-
6	504	135	133	12	-	-	-	-	-	-	-
7	282	50	50	-	-	-	-	-	-	-	-
8	372	75	75	69	-	90	50	15	7	-	-
9	474	93	93	-	-	-	-	15	-	-	-
10	365	93	93	71	11	-	11	-	-	-	7
11	508	100	100	1	-	-	-	15	-	-	-
12	339	78	76	77	-	36	36	15	-	-	-
13	291	76	76	17	-	-	-	-	-	2	-
14	309	90	90	-	-	-	-	15	-	3	-
15	244	-	-	-	-	-	-	-	1	-	-
16	581	75	75	1	-	-	-	-	1	4	-
*17	83	56	56	26	-	-	-	-	1	-	-
*18	256	62	62	60	-	45	34	15	-	-	10
19	449	75	75	-	-	-	-	15	-	6	10
<hr/>											
TOTAL	6896	1482	1448	471	21	573	312	165	59	15	35

* Bottom trawls

1 Stock Identification tissue samples included muscle and/or ovary.

2 Tissues sampled for the oil contamination study included liver, ovary, bile, stomach, blood serum, and/or otolith.

3 Blood sampled for reproduction studies provided material for vitellogenin purification.

Table 6. Inventory of CTD casts, from the winter 1991 Gulf of Alaska pollock survey, Miller Freeman cruise 91-2.

CAST NO.	HAUL NO.	DATE (1991)	TIME (AST)	POSITION		DEPTH (m)		COMMENT
				LAT (N)	LONG (W)	CAST/BOTT		
1	1	Mar 16	0809	54 08.9	162 21.2	472/593		Sanak I.
2	2	Mar 20	0501	56 31.0	156 12.4	248/275		Shelikof
3	3	Mar 20	1100	56 37.2	156 02.7	271/292		Shelikof
4	4	Mar 20	2151	56 49.4	155 42.5	266/282		Shelikof
5	5	Mar 21	1212	57 09.8	155 21.7	234/251		Shelikof
6	6	Mar 21	2241	57 16.8	155 11.0	224/237		Shelikof
7	7&8	Mar 22	1301	57 39.6	154 55.8	217/233		Shelikof
8	9	Mar 23	0218	57 55.7	154 40.1	228/249		Shelikof
9	10	Mar 23	1221	58 02.7	154 13.7	262/276		Shelikof
10	11	Mar 24	2314	57 59.6	153 46.7	220/230		Shelikof
11	12	Mar 24	1220	58 09.8	154 04.8	289/296		Shelikof
12	13	Mar 24	1507	58 14.4	154 00.2	262/272		Shelikof
13	14	Mar 24	1934	58 07.3	153 38.3	188/200		Shelikof
14	15-17	Mar 25	1339	58 03.7	153 39.9	196/205		Shelikof
15	18&19	Mar 25	2000	58 12.4	154 01.9	261/279		Shelikof
16	Cal.	Mar 27	1527	58 13.0	153 02.2	101/111		Malina B.

Table 7. Inventory of XBT casts, from the winter 1991 Gulf of Alaska survey, Miller Freeman cruise 91-2.

CAST NO.	DATE (1991)	TIME (AST)	POSITION		DEPTH (m)		COMMENT
			LAT (N)	LONG (W)	BOTTOM		
53	Mar 19	1227	56 09.3	156 19.7	223		Shelikof
54	Mar 20	1159	56 35.4	155 52.8	256		Shelikof
55	Mar 21	0225	56 58.3	155 38.9	283		Shelikof
56	Mar 22	0209	57 28.8	155 27.2	293		Shelikof
57	Mar 23	0617	57 59.9	154 26.5	178		Shelikof
58	Mar 24	0406	58 11.5	153 26.7	189		Shelikof
59	Mar 26	0515	57 51.5	154 22.2	213		Shelikof